CENTER FOR INSTITUTIONAL REFORM AND THE INFORMAL SECTOR

University of Maryland at College Park

Center Office: IRIS Center, 2105 Morrill Hall, College Park, MD 20742
Telephone (301) 405-3110 • Fax (301) 405-3020

RETURNS TO SCALE IN A HIGHLY REGULATED ECONOMY: EVIDENCE FROM INDIAN FIRMS

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Brian Fikkert and Rana Hasan

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Authors: Brian Fikkert (IRIS), Rana Hasan, University of Maryland at College Park.

Returns to Scale in a Hiehlv Regulated Economv: Evidence from Indian Firms

Brian Fikkert
Department of Economics
3105 Tydings Hall
University of Maryland
College Park, MD 20742
(fikkert @ westmin.umd.edu)

and

Rana Hasan
Department of Economics
3105 Tydings Hall
University of Maryland
College Park, MD 20742
(hasan@econ.umd.edu)

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ABSTRACT

This paper examines returns to scale for a panel of large Indian manufacturing firms spanning the period from 1976 to 1985. The period is one in which the policy environment was characterized by industrial regulations that restricted firms' investment and expansion activities. Anecdotal and case study evidence has long supported the perception that these regulations led to unexploited scale economies in Indian firms. Our estimates of returns to scale support this view. Average returns to scale for the various industries range from 1.08 to 1.30 and returns to scale are significantly greater than one for a majority of the firms. Moreover, we find some evidence that the incomplete reforms of the latter half of the 1980s did not remove scale efficiencies in certain industries. Thus, there appears to be scope for the significant reforms of the 1990s to generate gains in efficiency from expansion of firm size.

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I. Introduction

Ever since gaining its independence in 1949, India has pursued a strategy of comprehensive economic planning which included restrictive trade and industrial policies that regulated virtually every aspect of firms' lives. Over the last two decades, however, Indian policy makers have experimented with various reforms designed to loosen the constraints imposed on firms, these reforms culminating in the sweeping changes of the New Industrial Policy of 1991. Reformers believe that India's interventionist government created substantial un-cxhausted economies of scale and widespread technical inefficiency as a result of policies which favored small-sized firms and which restricted firms' choices of levels of production,. product lines, capital stocks, and imports of goods and technology. Reformers hoped that greater competitive pressure and incrcnsed freedom to respond to market incentives would encourage surviving firms to adopt "best practice" technology and to increase their levels of output, thereby moving down their average cost curves.

In this paper we examine the extent to which Indian firms were characterized by un-exhausted economies of scale before major reforms were introduced. Establishing the existence of scale economies in the pre-reform era is crucial for determining whether there is any room for reforms to achieve productivity gains by enabling firms to expand their output levels. Unfortunately, previous empirical research examining the prevalence of returns to scale (RTS) in Indian industry has used cross-sectional data to estimate production functions or long-run cost functions and has often employed aggregate data at the industry or economy level, most studies finding evidence of constant or mildly increasing returns to scale. The use of cross-sectional data does not enable the econometrician to control for unobserved heterogeneity across observations, relegating unobserved heterogeneity to the error term where its correlation with the regressors is likely to result in inconsistent estimates. Furthermore, the estimation of a long-run cost function, which assumes that firms' capital stocks are at their long-run equilibrium levels, may not be appropriate for the Indian context in which the government exercised considerable influence over the size of firms' capital stocks. Finally, the use of aggregate data to study a micro phenomenon such as returns to scale is less than ideal, particularly when estimating a cost function for firms operating in an environment where capital stocks and output levels may not be chosen optimally. Different historical experiences are likely to result in firms being on different short-run cost curves, making aggregation, which assumes that firms are identical, a highly questionable procedure. We try to overcome these shortcomings in previous work by estimating a short-run, Translog cost function using panel data from 232 firms belonging to six manufacturing industries for various years from 1975-76 to 1984-85. We include a time-varying fixed effect for each fii so that unobserved differences in fiis' productivity levels at each point in time are no longer part of the error term, thereby removing the aforementioned source of bias likely to exist in cross-sectional studies.

In contrast to previous work, we find evidence of unexploited scale economies for a large number of firms in the sample. As will be discussed further below, the sampled firms are among the largest in India. Hence, while it is conceivable that smaller firms use less scale-intensive technology, the finding of unexploited scale economies in the largest firms in India suggests that the phenomenon may have been widespread.

We also attempt to determine whether firms responded to the relatively more liberalized environment of the latter half of the 1980s by expanding production to reap economies of scale.

We find some evidence that these reforms did not lead to a sufficiently large output response in some industries; hence, there is scope for the New Industrial Policy of 199 1 to achieve further productivity gains.

The paper is organized as follows. Section II briefly reviews India's industrial licensing system and surveys the reform efforts. Readers well-acquainted with these issues can skip this section without loss of continuity. Section III presents the methodology used to estimate RTS, while section IV provides a description of the data set and variables used in estimation. Section V details the results from the estimation and provides a comparison with previous literature. Finally, Section VI concludes the paper with some comments.

II. Industrial Regulation in India.

It is beyond the scope of this paper to examine the evolution of India's industrial policies in detail. However, the most important features of the industrial regulatory system as it influenced the environment in which Indian firms operated are discussed here.

The centerpiece of the industrial regulatory apparatus was industrial licensing. The Industries (Development and Regulatory) Act of 195 1 required every investor over a very small size to obtain a license before the establishment of an industrial plant, addition of a new product line to an existing plant, substantial expansion of output, or a change of a plant's location. Applications for industrial licenses were submitted to the Licensing Committee (LC) , which examined each proposal in light of the national planning targets for industrial production and investment in the various sectors. The LC was assisted in its task by the Directorate General of Technical Development in determining the technical viability of the proposed manufacturing process, the investment in capital stock that was "commensurate" with the output (capacity) applied for, and whether the applicant's plan for the production process entailed the maximum possible "indigenisation" within a reasonable time span (Bhagwati and Desai 1970).[1]

If the application for an industrial license involved the import of capital goods, a capital goods license had to be obtained from the Capital Goods Committee (CGC) for an allotment of foreign exchange. Due to concerns about the scarcity of foreign exchange, the CGC tended to be more rigid than the LC in ensuring that the proposed capital investment was really necessary to achieve the capacity applied for (Hazari 1986).[2] Hence, there were restrictions on both firms' output and capital stock levels.

There are a number of reasons to believe that India's capacity licensing system resulted in firms producing below minimum efficient scale. First, India's goal of balanced regional development caused the LC to allot capital and output on a regional basis, thereby reducing a production unit's output below laissez-faire levels and perhaps below the minimum efficient scale. Second, overall capacity was frequently broken up into several production units for the purpose of "fostering competition". For example, Edquist and Jacobson (1985) report that South Korea and India obtained technology from the same French firm for the production of hydraulic excavators. Whereas two firms produced between 600 and 1,500 units per year in South Korea,

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[1] It had become apparent by the mid-sixties that the excessive rigidity of the licensing system had bred serious inefficiencies: there were instances of firms accused of violating the law on account of producing output beyond their licensed capacity, having achieved this either through organizational changes or improved utilization of existing capital. An adjustment of the licensing policy in 1966 relaxed this constraint. The new policy allowed firms automatic increase in output of up to 25 percent more than their licensed capacity as long as the increased production did not entail any additional foreign exchange, additions to plant and equipment, and the item produced was not reserved for the small scale sector.

[2] In 197576, the first year of data for the fiis in this study, the average age of fiis' capital stocks was 10 years, meaning that it was installed in 1966. Hazari (1986) finds that 70 percent of the licensed new investment in 1966 was imported and thus would have been subject to the most stringent criteria of the CGC.

the Indian government issued licenses to six firms and had each produce less than 150 units per year. Third, starting in 1967 many industrial products were "reserved" for the exclusive production of firms belonging to the small-scale sector, which consisted of firms with machinery and equipment of less than 2 million rupees. The actual number of products reserved for the small-scale sector grew from about 180 products initially to about 900 products by 1980 (Lall 1987). Larger firms that were producing an item before it was reserved were simply not allowed to expand their operations in this line.

Even more stringent controls on the expansion of capacity of large firms resulted from the passing of the Monopolies and Restrictive Trade Practices (MRTP) Act of 1969. The objectives of the MRTP were to prevent the concentration of economic power and check uncompetitive and "unfair" trade practices of large firms. Since the prevailing belief was that such practices stemmed naturally from large firm size and market share, controlling firms' sizes and market shares became the *defacto* objectives of the Act. Particularly large, dominant, or interconnected firms had to clear all their plans for entry, expansion, relocation, and merger with the Department of Company Affairs;.[3] Not surprisingly then, MRTP firms typically faced greater delays in obtaining industrial licenses than did other firms (World Bank 1986).

Although a number of tentative reforms were introduced from 1975-1984, most observers agree that, as a whole, these reforms were marginal and the industrial licensing regime continued to impose binding constraints to entry and growth for most firms outside the small-scale sector

[3] An important criterion for determining whether a firm was to come under the purview of the MRTP Act was the asset value of the firm. The asset limit, set at Rs 200 million in 1970 when the Act took effect remained unchanged for a period of fifteen years.

(Ahluwalia 1985; Desai 1995; Marathe 1986; Wadhwa 1993; World Bank 1986).[4] For example, Lall (1987) reports that Bajaj Auto was constrained by the government to produce only 173,020 units in 1980-81 even though there was a 10 year waiting list for its scooters. After 8 years delay, Bajaj was finally permitted to expand production to 250,000 units and was hoping for an additional license to increase production to 650,000 units.

More serious liberalization of the capacity licensing regime began in 1985 with further de-licensing of 25 industries, greater product diversification permitted in some industries, and fewer controls on MRTP firms operating in specified industries.[5] Furthermore, a trade liberalization in 1985 relaxed some import controls on intermediate and capital goods by expanding the list of inputs that could be imported without any license at all, the fraction of such imports rising from 5 percent in 1980-81 to about 30 percent in 1987-88 (Panagariya 1994).[6] Perhaps of greater significance was the apparent change in the mind-set of policy makers. For example, whereas Bhagwati and Desai, writing in 1970, discuss the absence of even the "comprehension" of the issues of scale and efficiency on the parts of the policy makers, licensing policies in 1986 stipulated the need for new investments in certain industries to be

[4] In Desai's (1995) view, the government's control of financial institutions and the policy of favoring government enterprises and small scale firms in the allocation of credit could be expected to restrict the size of Indian firms even if licensing policies were relaxed considerably, given the under-developed state of the capital market.

[5] An additional relaxation was the increase in the asset limit above which companies came under the purview of the MRTP Act from Rs 200 million to Rs 1 billion in 1985.

[6] Goods that could be imported without a license fell under the Open General Licensing (OGL) list. An application to import a capital good on the OGL list could, however, be rejected by the CCC and the productive capacity associated with the capital good in question still required an industrial license.

consistent with "minimum economic scales" of production.[7] Hence, as mentioned earlier, there is some reason to suspect that any un-exhausted economies of scale may have been removed after 1986 as policy-induced impediments to growth were alleviated.

The most dramatic changes in India's industrial regulatory environment were announced in the New Industrial Policy of 1991, which is believed to have de-licensed about 80 percent of Indian industry and relaxed substantially the controls on imports of intermediate and capital goods. Currently, the imports of most intermediate and capital goods are not subject to licensing and tariff rates do not exceed 65 percent. This is in stark contrast to the earlier era characterized by a pervasive system of quotas and tariff rates that averaged over 120 percent. The hope is that removing the shackles from domestic firms will permit expansion by the most productive enterprises, thereby removing unexploited economies of scale, permitting the more efficient firms to produce a greater fraction of domestic output, and encouraging more rapid rates of innovation.

III. Methodology

The approach used in this study is to measure long-run returns to scale (RTS), defined as the percentage increase in output per percentage increase in all inputs, via the estimation of a short-run variable cost function. Unlike the estimation of a long-run cost function, this requires a measure of each firm's capital stuck to be included as a regressor. While this is always a bit difficult due to problems with the measurement of capital, the circumstances under which Indian fii were operating make it very difficult to accept the notion that firms were free to choose

[7] Accordingly, investments in the specified industries had to be consistent with announced minimum scales of production and incumbent firms were encouraged to expand to these levels if they were initially operating at lower scales.

their capital stocks optimally, i.e. that the firms were in long-run equilibrium with regards to capital. As discussed earlier, India's pre- 1985 industrial licensing policies severely constrained firms' choices of both capital and output.[8] While both could be altered within very limited ranges in the short-run, major changes in either capital or output required firms to apply for expansion licenses. As these regulations often imposed binding constraints on firms' behavior, it seems reasonable to assume that firms were often in a disequilibrium state with regards to capital and output in the short-run. Estimating a short-run cost function conditional on each firm's capital stock is, therefore, more appropriate than estimating a long-run cost function which assumes that firms' capital stocks were chosen optimally.

Formally, it is assumed that the firm chooses labor and materials to minimize the costs of producing a particular level of output, given its present capital stock.' Then there exists a short-run variable cost function for firm i at time t given by:

$$CV_{it} = CV(P_{it}, Q_{it}, K_{it}, t, \alpha_{it}) \tag{1}$$

where CV is variable cost, which is equal to $P_L \cdot L + P_M \cdot M$, where L is labor and M is materials, the two variable inputs; $P = [P_L \ P_M]$ is a vector of prices of the variable inputs; Q is the level of output produced; K is the level of the capital, the fixed input; t denotes time; and α is a firm-specific, technology level which may be observed by the firm but not by the econometrician.

[8] See Section II.

[9] One might argue that Indian firms were not completely free to adjust their labor forces as well. There is some truth to this argument, for labor laws reduced firms' flexibility with regards to layoffs. However, firms could still adjust the size of their labor forces through hiring and laying off informal laborers. Hence, there was likely to be labor flexibility at the margin, which is all that is required for the cost function used here to be appropriate.

Note that short-run total cost ($SRTC$) is:

$$SRTC_{it} = CV(P_{it}, Q_{it}, K_{it}, t, \alpha_{it}) + r_{it} \cdot K_{it} = f(P_{it}, Q_{it}, K_{it}, r_{it}, t, \alpha_{it}) \tag{2}$$

where r is the rental price of capital.

The parameters of the short-run variable cost function can be used to determine long-run RTS using results from the first order conditions of the short-run cost minimization problem [as in Caves, Christensen, and Swanson 1981):

$$RTS = \frac{1 - \dfrac{\partial \ln CV(.)}{\partial \ln K}}{\dfrac{\partial \ln CV(.)}{\partial \ln Q}} \tag{3}$$

RTS numbers greater than 1 indicate unexploited scale economies, i.e. the presence of increasing returns to scale (IRS). For example, if the estimated RTS is 1.3 it indicates that a **1** percent *increase in* the use of all inputs will result in a 1.3 percent rise in output. Under perfect competition with free entry and exit, economic theory predicts that firms will increase output to the point where RTS is equal to **1.**

A more appropriate measure of the economic benefits from the long-run expansion of output may be the elasticity of size. Whereas RTS describes how much output changes in response to a *proportionate* increase in all factor inputs, elasticity of size measures how costs **of** production **respond to changes *in*** output along ***long-run cost-minimizing*** **combinations of factor inputs.** The two measures will, in general, only coincide for homothetic production technology. In the case of non-homothetic technology, the elasticity of size associated with any given level of output may be obtained by evaluating equation 3 at the level of capital stock that is optimal for producing that output (Oum, Tretheway, and Zhang 1991). As discussed in appendix 1, we employ numerical methods to obtain the optimal level of capital stock for each fii and thus compute elasticity of size. A comparison of elasticity of size and RTS for our six industries reveals that the numbers are very close for four industries (electrical machinery, non-electrical machinery, pharmaceuticals, and paper). Thus, for these industries, the RTS numbers can also be considered to be representative of the elasticity of size. For the remaining two industries, auto vehicles and basic chemicals, the measured elasticities of size were highly sensitive to the interest rate used to compute the rental price of capital, so comparisons of elasticity of size and RTS were less conclusive (see appendix 1 for details).

The functional form chosen for this study is the Translog, which is a member of the family of "flexible functional forms". That is, the Translog does not impose any restrictions on the $[(n+1)\cdot(n+2)]/2$ distinct economic effects of a one-output n-input production process, which in the case of a cost function are: output level, marginal cost, the n-l distributive shares, $n\cdot(n-1)/2$ elasticities of substitution, and n own price elasticities (Fuss, McFadden, and Mundlak 1978). In particular, we estimate a short-run Translog cost function with capital as a quasi-fixed factor. It may be noted that modeling an input as quasi-fixed if it is really free does not lead to any mis-specification. On the other hand, modeling a quasi-fixed factor as if it were free does lead to a bias, whose direction, contrary to some assertions, cannot be signed *a priori* (Oum, Tretheway, and Zhang 1991). Our specification of the short-run, Translog cost function is:

$$lnCV_{it} = \alpha_{1i} + \alpha_{2i} \cdot t + \sum_{t=1}^{T} \beta_t \cdot D_t + \beta_Q \cdot lnQ_{it} + \beta_K \cdot lnK_{it}$$

$$+ \frac{1}{2} \cdot \beta_{QQ} \cdot (lnQ_{it})^2 + \frac{1}{2} \cdot \beta_{KK} \cdot (lnK_{it})^2 + \beta_{QK} \cdot lnQ_{it} \cdot lnK_{it} + \beta_{QL} \cdot lnQ_{it} \cdot lnP_{Lit}$$

$$+ \beta_{QM} \cdot lnQ_{it} \cdot lnP_{Mit} + \beta_{KL} \cdot lnK_{it} \cdot lnP_{Lit} + \beta_{KM} \cdot lnK_{it} \cdot lnP_{Mit} + \epsilon_{it} \qquad (4)$$

where D_t is dummy variable for year t, all other Roman letters represent previously defined variables and ϵ_{it} is an error term and is assumed to be identically and independently distributed across firms and time and uncorrelated with the regressors.

There are several features of our particular specification worth noting. First, the firm-specific technology parameter, α_{it} , is modeled as a cost-neutral, time-varying fixed effect. Cost-neutral means that it does not interact with the other regressors, i.e. it does not effect the overall structure of production. Time-varying means that each firm's technology can change over time according to the following specification: $\alpha_{1i} + \alpha_{2i} \cdot t$. It is important to include a firm effect , α_{1i} , as a regressor for it is likely that firms which have higher levels of technical efficiency will have applied for licenses to expand their output and capital stocks. Hence, there is likely to be correlation between firms' unobserved efficiency and their output and capital." Additionally, the assumption that each firm's technology is constant over time may be a rather strong one given

[10] Moreover, if the actual mix of products produced by individual fiis within an industry varies with firm size, then it is likely for an estimator based on a simple pooling of the data to lead to biased estimates of RTS (Tybout and Westbrook forthcoming). In such a case, estimation which takes into account the heterogeneity of product lines across firms by explicitly using firm effects as regressors is to be preferred.

the long time panels of many of our firms (ten years for almost 100 firms) and can potentially lead to inconsistent estimates (Cornwell, Schmidt, and Sickles 1990). We relax the time invariance of the firm effect by including a firm specific time trend, a $_{2i}{\cdot}t$. Failure to include $\alpha_{1i} + \alpha_{2i}{\cdot}t$ as regressors may then cause correlation between the error terms and Q and K, resulting in inconsistent estimates.

Second, the assumption that ϵ_{it} is uncorrelated with the regressors is valid if any one of the following conditions is true: (1) ϵ_{it} is simply measurement error in cost; (2) ϵ_{it} is a shock to costs which firms do not observe before choosing levels of Q and K; (3) ϵ_{it} is observed by firms but they are unable to adjust Q and K in response to information about ϵ_{it} at time t. Assuming Q and K do not adjust this period to ϵ_{it} seems reasonable in the Indian context where the licensing system would only permit firms to adjust Q and K over longer periods of time.

Finally, because the period under consideration was witness to several shocks to the Indian economy at different points of time, time dummies, D_t , are included as regressors. The sources of these shocks included erratic supplies of foreign exchange and infra-structural bottlenecks resulting from periodic shortages of electric power and unreliable transportation services. The net result were delays in manufacturing activities and frequent stoppages of production. The easiest way to capture these exogenous shocks is through the use of time dummies. These dummies are necessarily perfectly correlated with the wage and price data, which are also at an industry level. Hence, the non-interactive wage and price data from the standard Translog need to be suppressed in the estimation procedure.

The results presented in this paper follow from the estimation of equation 4 with linear homogeneity in prices imposed.[11] Estimates for RTS are then obtained by evaluating equation 3, above.

IV. Data Set Description

The data set used in this study consists of the annual reports of 232 "public limited" firms, defined as private corporations with more than 50 shareholders.[12] Data are available for four panels of firms. The first panel consists of data for 1975-76 to 1980-8 1 on a sample of "medium" scale firms from the universe of public limited firms with more than Rs. 500,000 of nominal, paid-up capital in 1975.[13] The second and third panels consists of data for the -1975-76 to 1983-84 and 1975-76 to 1984-85 periods, respectively, on a sample of "large" scale firms from the universe of public limited firms with more than Rs.10 million of nominal, paid-up capital in 1984. A fourth panel of similarly large firms consists of data for the 1980-81 to 1984-85 period.[14] Thus, the data for the medium scale firms cover the period 1975-76 to 1980-8 1 (panel 1), whereas the data for the large scale firms cover either the period 1975-76 to 1983-84 (panel

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[11] Linear homogeneity in input prices involves the restrictions, $\beta_{QL} = -\beta_{QM}$ and $\beta_{KL} = -\beta_{KM}$. The complete set of restrictions for linear homogeneity of prices would also include $\beta_L + \beta_M = 1$ and $\beta_{LM} = -\beta_{LL} = -\beta_{MM}$. However, given the perfect collinearity between factor prices and time dummies, these cannot be imposed.

[12] We are most grateful to the Institute for Studies in Industrial Development of New Delhi, India for providing the firm-level information.

[13] The Reserve Bank of India distinguishes between "medium" and "large" scale firms in its classification system.

[14] The sampling of firms was performed in such a manner that a firm was only included in the panel if data for that firm were available for all of the years of the panel. If data were unavailable for a firm for some exogenous reason, this sampling procedure creates no particular problem. However, if data were unavailable for a firm because it had exited over the course of the panel, then this sampling procedure would introduce selectivity bias: only successful firms would be in the sample. However, due to the exit policies of the Indian government, very few large and medium scale firms exit in any year, so sample selectivity is not a problem in this case. See Fikkert (1994) for details.

2), 1975-76 to 1984-85 (panel 3), or 1980-81 to 1984-85 (panel 4). Notice that the data covers the decade immediately preceding the reforms of the mid-1980s, which as we have discussed in section II, is when serious reform of the licensing system began to take effect. Because the overlap of these four panels is the year 1980-8 1, much of the discussion of the results focuses on this year. For some of the large scale firms, data are also available for the year 1988-89, so this data will be used to examine whether the de-licensing introduced in the mid-eighties enabled firms to expand their production, thereby removing any unexploited scale economies or whether significant scale economies persisted at the commencement of the New Industrial Policy of 1991.

The firms span six industries at the 2 ½ digit level of disaggregation: (i) auto vehicles, (ii) electrical machinery, (iii) non-electrical machinery, (iv) basic chemicals, (v) pharmaceuticals, and (vi) paper. Table 1 details the number of firms in each panel and industry. The firms comprising the data set are the largest in their respective industries. Consider Table 2 which presents the value of production of the sample firms as a percentage of total industry output in 1980-81. Clearly, these firms account for a sizeable fraction of their industries' output. Consider also Tables 3a-3b, which detail the size distribution of firms in India and the size distribution of the firms in the data set, respectively. Table 3a indicates considerable skewness in factory size for India as a whole." Note that the largest category of factories, those with gross value of plant and equipment in excess of Rs 2 million, comprise only 6.6 percent of registered factories; however, they account for almost 60 percent of total employment and 74 percent of total output. Where do the sample firms lie in this distribution.? As Table 3b illustrates, out of 232 firms,

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[15] The data in Table 3a come from the Annual Survey of Industries (ASI), which uses the term "factory" rather than "fii,"; however, firms that *operate* multiple *factories in the* same state are allowed to present a single consolidated return, so comparing such "factories" with the "firms" in our data set may not he too inaccurate.

only 9 had gross value of plant and machinery below Rs. 2 million, the largest category of firm. Clearly, the firms in this data set are amongst the largest in India. If unexploited scale economies exist in such firms, they may exist to a much greater degree in the country as a whole.

As has been discussed above, the approach of this study is to estimate short-run variable cost functions for each firm. The assumption is that there are two variable inputs, labor and materials, and one fixed input, capital; hence, data is needed for wages, materials prices, capital stocks, output, and variable costs for every year. Industry specific wage data was computed by dividing each industry's "total emoluments to employees" by the "total number of labor hours worked" using the industry level data reported in the Annual Survev of Industries of India, while India's input-output matrix was used to weight output price indices in order to construct an industry-specific, materials price deflator.[16] A description of the construction of a constant rupee, net capital stock for each firm is given in Appendix 2. Firms' output was deflated to constant 1985-86 rupees using industry-specific, output price deflators. Finally, firms' variable costs were defined to include all non-capital costs as reported in the firms' annual reports. These non-capital costs consist of payments made for labor and materials inputs and "other manufacturing expenses" which are not itemized further and thus cannot be split into separate labor and material inputs.

Because the variables used in estimation may be subject to measurement error-- capital stock in particular-- we used two "cleaning" procedures to remove outliers. First, we adopted a procedure similar to one utilized by Hall and Mairesse (1992) and removed all observations for

[16] The output price indices were obtained from Chandhok and the Policy Group (1990) which reports wholesale price deflators at the three-digit level.

which the rate of growth of output, capital stock, labor, or materials was greater than 300 percent or less than 90 percent. This step removed 9 observations out of a total of 1,823 observations. Second, we removed all observations for which the capital to labor ratio displayed "spikes". That is, we removed an observation if an increase (decrease) in the capital to labor ratio of 30 percent or more was immediately followed by a decrease (increase) of 30 percent or more. Eight observations displayed such spikes but since one of these was also detected using our first procedure, we deleted a total of 16 observations when using both procedures. The estimations were thus carried out with a total of 1,807 observations, a reduction of less than one percent of the original sample."

V. Estimation Results.

The parameter estimates of the fitted short-run cost function are presented in Table 4 for all six industries. The imprecision of some of the estimates coupled with high adjusted R^2 values indicates that multi-collinearity may be present. However, in the context of the present study, this is not very problematic; the variable of interest is RTS , which being a function of the parameter estimates, may be estimated with more precision. We evaluate RTS for each industry

[17] A comparison of RTS estimates derived from OLS applied to differenced data suggests that measurement error in our data set is much less severe than that found in other studies that use micro-level panel data from other developing countries. As argued by Griliches and Hausman (1986), while correlation between regressors and unobserved firm effects may be removed by using data differenced by any length, the bias that results from measurement error in the regressor varies with the length of the differencing. Thus, large differences in estimates from data differenced by various lengths may be indicative of serious measurement error. Because, the longest differencing possible with our data set is fourth differencing (panel 4 fiis have five years data), we compared our estimates of RTS derived from first and fourth differenced data with similarly derived estimates of Westbrook and Tybout (1993) who estimate RTS via a Cobb-Douglas production function using Chilean data. Whereas the average difference between Westbrook and Tybout's (1993) first and fourth differenced estimates of RTS for the four industries that overlap with our study's is about 388 percent, we fmd an average difference of only 8.75 percent between RTS estimates from first and fourth differenced data.

by substituting the respective parameter estimates into equation 3. Because RTS is a function of each firm's level of Q and K, it will vary by firm. Table 5 presents the average RTS estimates for each panel over time. As we would expect, the RTS numbers for panel 1 are always higher than for panels 2, 3 and 4. Recall that panel 1 firms are "medium" scale, while panel 2, 3 and 4 firms are "large" scale; hence, the higher RTS figures for the panel 1 firms can be attributed to their smaller size. Note that all of the RTS numbers are greater than 1, indicating the pervasiveness of unexploited scale economies. Notice also that for most of the panels there is considerable persistence in the. RTS numbers over time. In other words, firms were not expanding rapidly to take advantage of their unexploited scale economies.

A better sense of the distribution of output and firms across various RTS values can be obtained by examining figures 1 and 2, which graph data from 1980-81, the year in which all four panels overlap. Figure I presents scatter plots of firms' output and RTS in 1980-81. Only five firms displayed RTS less than one. Figure 2 presents the fraction of sample output produced by firms operating within various range of RTS. In all but two of the industries--autos and non-electrical machinery--the majority of sample output is produced in regions estimated to have increasing returns to scale. However, even in autos and non-electrical machinery there are firms operating at far below the minimum efficient scale (see figure 1). Furthermore, virtually all of the firms in electrical machinery, chemicals, pharmaceuticals, and paper are estimated to be producing in regions with RTS greater than I.0 (IRS).

But is this evidence of IRS statistically significant? Table 6 reports the t-statistics for the tests of the difference between each firm's estimated RTS and 1.0 by range of RTS, and additionally, the percentage of sample firms with estimated RTS lying in that range of RTS.

Significant IRS are found for at least half of the firms in five industries at the five percent level of significance and all six industries at the ten percent level of significance. Similarly, Table 7 indicates that the simple mean of RTS across firms is greater than 1 in every industry and is statistically significant in all industries except autos. Of course, larger firms naturally have lower **RTS** and account for a higher percentage of industry output. Hence, it is conceivable that very little output was produced in regions with statistically significant IRS. However, as the last row of Table 7 indicates, with the exception of autos and non-electrical machinery, a very high fraction of sample output is produced in regions with significant IRS.

As discussed earlier, there was some de-licensing in 1985, so it is conceivable that firms expanded their capital stocks and output during the second half of the 1980s, thereby removing their unexploited scale economies. If **so,** there would be little left for the New Industrial Policy of 1991 to accomplish. Recall that for a subset of the panel 3 and 4 firms, data is available for 1988-89 as well. The data on capital and output for these fiis were used along with the parameter estimates and price deflators for labor and material to compute their RTS in 1988-89 in order to get a sense for their position just prior to the New Industrial Policy. As Table 8 reports, for the electrical machinery and paper industries, there is some evidence that expansion led to gains in scale efficiency, although there were still unexploited scale economies in paper in 1988-89. In chemicals and pharmaceuticals, we find a persistence in RTS through time at relatively high levels of about 1.13 and 1.08, respectively. In autos and non-electrical machinery, there is very little movement, the RTS numbers remaining around 1. Hence, it appears that there is room for the dramatic de-regulations incorporated in the New Industrial Policy to enable firms to achieve gains in scale efficiency. Moreover, the firms used in this *analysis are amongst the* largest in India; if IRS are present in these firms, they may be present to a greater degree in the population of firms as a whole.

As mentioned earlier, there have been a number of studies of returns to scale in India, but the vast majority of them have used highly aggregated data. The most popular approach has been to estimate production functions with pooled, industrial-level data, with most *studies finding* constant or mildly increasing returns to scale (Ahluwalia 1991; Banerji 1975; Goldar 1986; Mehta 1980). The problem with this approach is that firms are not identical so aggregation may introduce errors and lead to inconsistent parameter estimates. Furthermore, in studies using financial data to estimate production functions, inputs that are not itemized separately into labor and materials will be ignored and this may lead to biased estimates of RTS. A number of studies have estimated cost functions using industrial-level data (Jha, Murty, Paul, and Rao 1993; Williams and Laumas 1984). Again, aggregation problems are likely to exist. Furthermore, these studies assume that firms were able to choose their capital stocks optimally, an assumption that hardly seems tenable in the Indian policy environment.

One study which uses micro-level data is Ramaswamy (1993), who estimates production functions for four industries using data on small-scale firms. He finds evidence of mild increasing returns to scale, but his use of cross-sectional data and his failure to instrument for his regressors is likely to introduce correlation between the regressors and any unobserved firm characteristics, leading to inconsistent estimates. As mentioned earlier, the research presented here includes time-varying fixed effects so that unobserved firm characteristics are included as regressors.

There are a number of studies which examine returns to scale using micro data from other less developed countries. Westbrook and Tybout (1993) estimate a Cobb-Douglas production function for nearly all the Chilean manufacturing plants with more than 10 workers during the period 1979-1986. They use a variety of estimation techniques, but their most preferred estimates of returns to scale lie in the range of 0.8-1.2, with none of them being statistically different from 1.0. Similarly, Tybout and Westbrook (1995) estimate Translog production functions and long-run cost functions for Mexican plants during 1984-1990 using the "between" estimator. Although the smallest Mexican plants were not included in the sample, the plants which were in the sample accounted for 80% of total industry output. The results indicate some evidence of increasing returns to scale amongst the smaller plants, but constant returns to scale predominate in the larger firms.

The Tybout and Westbrook studies are the *most* comparable to the research presented here. On the whole, their results indicate much lower returns to scale in Chile and Mexico than we find for India even though their samples include a much higher percentage of small firms than ours. Our sample includes only the upper tail of the size distribution, yet we find higher returns to scale for these firms than Tybout and Westbrook find for most of their sample. Put differently, the largest firms in Chile and Mexico have constant returns to scale, while the largest firms in India have significant, increasing returns to scale. When viewed in this light, India's capacity licensing regulations appear to have been very costly.

It must be admitted that while the results indicate large, unexploited economies of scale in Indian industry, we have not actually demonstrated that it is the capacity licensing regulations that are the cause of this situation. For example, the import substitution regime could be responsible for lowering the elasticity of demand for firms' products, thereby causing them to move up their average cost curves as suggested by the "new trade literature" (see Krugman 1979). However, the large size of the Indian market seems to make this less likely in the Indian case. Another possibility is that Indian firms have not had access to sufficient financing to enable them to undertake large-scale investments.[18] Indeed, Athey and Reeser (1994) suggest that external finance, which is largely controlled by the state-owned financial institutions, was often directed toward the small-scale sector, leaving few sources of funds for medium and large scale firms to expand. In this light, the presence of financing constraints does not undermine the importance of the licensing regime but should be seen an part of a comprehensive set of policies biased against larger firms. Furthermore, given all of the anecdotal evidence concerning the constraints which the capacity licensing regime placed on firms, it is difficult to imagine that other factors were as significant in causing unexploited scale economies in India.

VI. Conclusion

In this paper we have estimated KTS using panel data for a sample of Indian manufacturing firms for the period 1975-76 to 1984-85 and found evidence of un-exhausted economies of scale both in terms of the existence of a large number of firms characterized by operations below minimum economic scale and the production of a sizeable proportion of sample output in certain industries by firms which had not achieved minimum economic scale. The evidence is therefore consistent with the belief that the biases against large firm size inherent in India's industrial policies till the mid-1980s resulted in inefficient scales of operations. Additionally, using post-sample data for a subset of firms (1988-89), we have found that the

[18] For a related view on issues of finance and inefficient scales of production, see Chandrasekhar (1992).

relatively more liberalized environment of the latter half of the eighties did not remove the unexploited scale economies in certain industries. This suggests to us that the new wave of reforms has the potential to generate efficiency gains as remaining constraints on firm expansion are removed.

Appendix 1: Measuring Returns to Scale and Elasticirv of Size.

Let $Q=f(X)$ represent the production function, where Q is output and X is a vector of three inputs, capital, labor, and materials (X = [K, L, M]). Further, let us define returns to scale (RTS) as the increase in output which results from a proportional increase in all inputs. It is also sometimes referred to as elasticity of scale and may be expressed as:

$$RTS \equiv \frac{df(\lambda X)}{d\lambda}\cdot\frac{\lambda}{f(X)}\Big|_{\lambda=1} = \frac{\frac{\partial f}{\partial K}\cdot K + \frac{\partial f}{\partial L}\cdot L + \frac{\partial f}{\partial M}\cdot M}{f(K,L,M)} \qquad \text{(A1.1)}$$

where λ is a scalar.

As mentioned earlier, Caves, Christensen, and Swanson (198 1) use comparative statics to infer RTS via the short-run variable cost function:

$$RTS = \frac{1 - \frac{\partial \ln CV(.)}{\partial \ln K}}{\frac{\partial \ln CV(.)}{\partial \ln Q}} \qquad \text{(A1.2)}$$

where $CV(.)$ represents the short-run variable costs and are a function of the prices of the variable inputs, output, capital stock, and technology, i.e., $CV = CV(P, Q, K, t)$, and $P=[P_L, P_M]$. In particular, for the cost function used in this paper, equation A1.2 reduces to:

$$RTS = \frac{1 - [\,\beta_K + \beta_{KK}\cdot\ln K_{it} + \beta_{QK}\cdot\ln Q_{it} + \beta_{KL}\cdot\ln P_{Lit} + \beta_{KM}\cdot\ln P_{Mit}\,]}{\beta_Q + \beta_{QQ}\cdot\ln Q_{it} + \beta_{QK}\cdot\ln K_{it} + \beta_{QL}\cdot\ln P_{Lit} + \beta_{QM}\cdot\ln P_{Mit}} \qquad \text{(A1.3)}$$

A concept similar to that of RTS is the elasticity of size, denoted by θ, and may be computed as the inverse of the elasticity of long-run costs with respect to output:

$$\theta = 1 \Big/ \frac{\partial \ln CT(P,Q,r)}{\partial \ln Q} \tag{A1.4}$$

where $CT(.)$ represents long-run costs which are a function of P. Q. and r, the rental cost of capital. Whereas RTS measures the response of output as one moves along a ray from the origin in input space, the. elasticity of size describes cost changes associated with changes in output along an *expansion path.*

It can be shown, following Morrison (1985), that RTS is equivalent to elasticity of size for a homothetic technology, i.e., RTS $= \theta$. If instead, technology is non-homothetic, one can use the methodology developed in Oum, Tretheway, and Zhang (199 1) to infer elasticity of size from the short-run cost function. Their study demonstrates that substitution of the optimal level of capital stock, K^*, in place of the actual level, K, in equation A 1.2 (and thus, A1.3) yields elasticity of size. The optimal capital stock is simply that which minimizes the total costs of producing the given level of output, Q.

It is useful to go over the motivation of Oum, Tretheway, and Zhang (1991) in terms of a figure (see below). Suppose that a firm is constrained to produce output level Q using K_f amount of the quasi-fixed input. It chooses the amounts of the variable input(s) to minimize costs. Let point *A*, in the figure below, denote the choice of *L*. Evaluating RTS at point *A* using the equation Al.3 is akin to measuring output response along a ray passing through the origin and point *A*. Note that if technology is non-homothetic, RTS at point A, will in general, be different from RTS at point B, which represents the long-run cost minimizing input

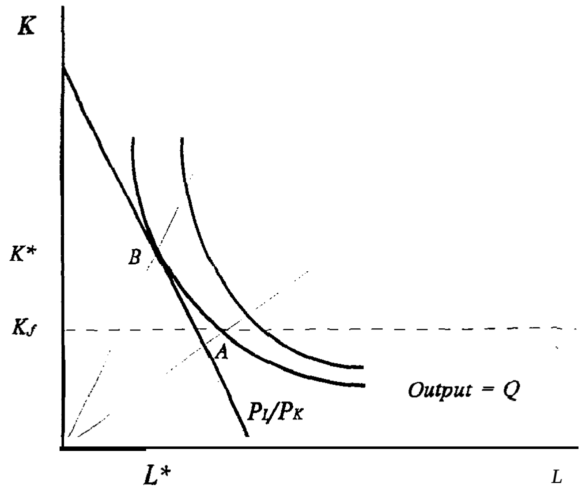

Figure a

combination, (K^*,L^*), for producing output level Q given factor prices, $P_L/\ P_K$. Furthermore, RTS measured at point B is equivalent to elasticity of size (Chambers 1988). To determine RTS at point B, the Oum, Tretheway, and Zhang (1991) procedure involves two steps. First, the optimal level of capital stock, K^*, required to produce output level Q must be determined. This is achieved by minimizing estimated short-run *total* costs with respect to capital. Then, the computed value K^* is substituted in place of the actual value, K_f, of the fixed factor in equation Al.3 for calculating RTS.

Since our chosen functional form, the Translog, is of non-linear logarithmic form, derivation of the optimal level of the capital stock requires a numerical method to minimize short-run total costs:

$$\min_{K} \ \hat{CV}(P_L,P_M,Q,K) \ + \ r \cdot K \qquad \text{(A1.4)}$$

That is, the optimal capital stock is that which minimizes the sum of estimated Translog variable cost associated with the production of output level Q and the cost of capital, $r \cdot K$. The rental price of capital, r, equals $P_K \cdot (\delta + i)$, where P_K is the investment deflator, δ is the rate of depreciation (assumed to be 6 percent), and i is the rate of interest (alternatively assumed to be 1, 8, 10, and 17 percent).[19] The optimal capital stock associated with actual level of production has been calculated for all firms in our sample for the year 1980-81 for all six industries, the year for which we have the greatest number of observations. Replacing the actual value of capital stock by the optimal values in equation A 1.3 gives us a measure of elasticity of size at a long-run optimum which can then be compared to our earlier estimates of RTS, derived using the actual values of the capital stock in equation A1.3.

For four industries, electrical machinery, non-electrical machinery, pharmaceuticals, and paper, the elasticity of size numbers are fairly insensitive to large changes in interest rates. Moreover, the difference between elasticity of size and RTS is marginal. For example, assuming a rate of interest of 10 percent yields share weighted elasticity of size of 1.13 for electrical machinery, 1.04 for non-electrical machinery, 1.09 for pharmaceuticals, and 1.23 for paper. The corresponding share weighted RTS numbers for the four industries using the actual values of the capital stock are almost identical: 1.11, 1.04, 1.08, and 1.22, respectively. This pattern is repeated for simple means of RTS and elasticity of size, and elasticity of size figures based on optimal capital stocks derived assuming interest rates of 1, 8, or 17 percent- Hence, the RTS numbers reported in this study for the four industries appear to be fairly good measures of the returns to size as well. For the remaining two industries, automobiles and basic chemicals,

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[19] Various interest rates, expressed in percent per annum, for 1980-81 were as follows: call money market rate: 7.24; bank rate: 9.0; commercial lending rate (prime): 16.50.

optimal capital stocks (and, therefore, elasticity of size) for many firms were very sensirive to interest rates. Hence, it is likely to be inappropriate to consider our RTS numbers as indicative of elasticity of size for these two industries.

Appendix 2: Construction of Capital Stocks.

We follow the procedure outlined in Basant and Fikkert (forthcoming) to construct a firm specific capital stock variable, K_t, that is net of depreciation and expressed in constant 1985436 rupees. The first step is to compute the average age of the capital stock in the first year for which a firm's data is available. This is done by using values of accumulated depreciation (AD) and total gross fixed assets $(TGFA)$, both of which are in our data set and by making the *assumption* that full depreciation of a firm's capital stock takes 16 years for accounting purposes. In this case, the average age (AA_i) of a firm's capital stock is;

$$AA_i = [AD_i/TGFA_i]\cdot 16 \tag{A2.1}$$

If we assume further that all of the capital stock in the first year has been purchased AA, years ago the capital stock in 1985-86 rupee value is:

$$K_{i0} = [TGFA_{i0}/P_{K,\,0-AA_i}]\cdot[1-\delta]^{AA_i} \tag{A2.2}$$

where δ denotes the rate of depreciation of the capital stock, t=0 represents the fist year for which a firm's data is available, and P_{Kt} is the value of the investment deflator in year t. In all future time periods $(t > 0)$, the firm's capital stock evolves as:

$$K_{it} = I_t + K_{it-1}\cdot[1-\delta] \tag{A2.3}$$

where I_t denotes investment and has been calculated as the difference in *TGFA* between years t and t-l, deflated by P_{Kt}. The rate of depreciation has been chosen to be 6 percent per annum.

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Table 1
Number of Firms by Panel and Industry

Industry	*Panel I (1976-81)*	*Panel 2 (1976-84)*	*Panel 3 (1976-85)*	*Panel 4 (1981-85)*	*Total*
Auto Vehicles	1	1	11	1	14
Electrical Machinery	9	1	11	3	24
Non Electrical Machinery	19	3	17	13	52
Basic Chemicals	20	10	21	4	55
Pharmaceuticals	15	6	23	6	50
Paper	18	3	14	2	37

Note: The years reported in this table refer to the latter half of the fiscal year. Hence. 198 1 represents the fiscal year 1980-1981.

Table 2
Value of Output in 1980-81 by Industry

Industry	*Value of Sample Output (Rs. 1,000)*	*As % of Total Industry Output*[a]
Auto Vehicles	15,543,282	81.07
Electrical Machinery	5,412.505	41.33
Non-Electrical Machinery	12,374,334	77.86
Basic Chemicals	8,83 1,945	12.43
Pharmaceuticals	10,265.029	86.4
Paper	5,322,770	63.79

Note: [a] Total Industry Output is from the ASI for fiscal year 1980-S 1.

Table 3a
Characteristics by Size of Plant and Machinery (1980-81)[a]

Plant & Machinery[b] *(Rs 100,000)*	*Factories (numbers)*	*As % of Total*	*Workers (numbers)*	*As % of Total*	*Gross Output (Rs 100,000)*	*As % of Total*
Up to 1	34,243	35.5	687,238	11.4	345,560	5.7
1-2.5	15,775	16.4	421,542..	7.0	287,995	4.7
2.5-5	9,137	9.5	346,543	5.7	281,816	4.6
5-7.5	4,006	4.1	210,690	3.5	169,784	2.8
7.5-10	2,560	2.6	143,947	2.4	145,068	2.4
10-20	3,444	3.6	279,868	4.6	303,021	5.0
Above 20	6,398	6.6	3,622,256	59.9	4,515,552	73.9
Unspecified.	20,940	21.7	334,508	5.5	59,607	0.9

Note: [a] Aggregates are of the three main sectors of economic activity covered by ASI: manufacturing (96% of factories). electricity, gas and water (0.5%) and repair services and cold storage (3.5%). [b] Plant and Machinery is in gross value.

Table 3b
Distribution of Sample Firms by Size of Plant and Machinery (1980-81)

Plant & Machinery (Rs 100,000)	*Auto Vehicles*	*Electrical Mach.*	*Non-Electrical Mach.*	*Basic Chemicals*	*Pharmaceuticals*	*Paper*
Up to 1						
1-2.5		1				
2.5-5						
5-7.5			1			
7.5-10						
10-20			2		2	2
Above 20	14	23	49	55	47	35

Table 4

Estimated Parameters

Parameter	*Auto Vehicles*	*Electrical Machinery*	*Non-Electrical Machinery*	*Basic Chemicals*	*Pharmaceuticals*	*Paper*
β_Q	0.6444	0.5596	0.8015	0.1459	0.7275	0.9621
	(1.68)	(4.62)	(7.54)	(1.36)	(6.10)	(6.02)
β_K	-0.2740	-0.6777	-0.1582	0.4663	-0.0998	-0.5227
	(-0.93)	(-3.50)	(-1.06)	(1.69)	(-0.62)	(-1.96)
β_{QQ}	-0.0537	0.1117	0.1166	0.0850	0.1290	0.0820
	(-0.46)	(4.19)	(3.87)	(2.96)	(6.64)	(2.31)
β_{KK}	-0.0676	0.1936	0.1304	-0.0473	0.1354	0.1033
	(-0.83)	(6.51)	(4.29)	(-1.12)	(4.13)	(2.58)
β_{QK}	0.0899	-0.0847	-0.1047	-0.0035	-0.1145	-0.0706
	(1.04)	(-3.78)	(-3.84)	(-0.11)	(-4.11)	(-2.27)
β_{QL}	-0.2174	0.0467	0.0365	-0.2830	0.1608	0.2240
	(-1.27)	(0.56)	(0.36)	(-3.36)	(2.46)	(1.08)
β_{KL}	0.1001	-0.0763	-0.0658	0.2696	-0.2033	-0.2308
	(0.56)	(-0.79)	(-0.59)	(3.06)	(-2.79)	(-1.16)
D_{77}	-0.2052	-0.0959	-0.0294	-0.0827	0.0414	-0.0823
	(-4.06)	(-5.11)	(-1.78)	(-3.25)	(2.36)	(-2.78)
D_{78}	-0.2505	-0.1013	-0.0457	-0.0829	0.0711	-0.1339
	(-4.19)	(-5.22)	(-2.57)	(-1.86)	(2.46)	(-2.96)
D_{79}	-0.2239	-0.0665	0.0240	-0.0118	0.0927	-0.1260
	(-3.66)	(-2.88)	(1.11)	(-0.18)	(2.20)	(-2.45)
D_{80}	-0.2522	-0.0992	0.0279	-0.0126	-0.0197	-0.1473
	(-3.12)	(-3.13)	(0.98)	(-0.15)	(-0.35)	(-2.28)
D_{81}	-0.2070	-0.1154	0.0610	0.0857	-0.0858	-0.1518
	(-2.15)	(-3.01)	(1.80)	(0.80)	(-1.21)	(-1.96)
D_{82}	-0.1507	-0.1495	0.0931	0.1307	-0.0802	-0.1704
	(-1.49)	(-3.34)	(2.40)	(1.03)	(-0.95)	(-1.84)
D_{83}	-0.1104	-0.1437	0.1061	0.1191	-0.0204	-0.2241
	(-1.03)	(-2.83)	(2.32)	(0.81)	(-0.21)	(-2.10)
D_{84}	-0.1324	-0.1501	0.1104	0.1122	0.0032	-0.2721
	(-1.21)	(-2.62)	(2.30)	(0.67)	(0.03)	(-2.29)
D_{85}	-0.0782	-0.1483	0.1341	0.0881	-0.0006	-0.2488
	(-0.67)	(-2.38)	(2.51)	(0.47)	(-0.01)	(-1.89)
Adjusted R^2	0.99	0.99	0.99	0.99	0.99	0.99

Note: Number under parameter estimate is the t-statistic.

Table 5
Estimated Average Returns to Scale by Panel and Industry

	Auto Vehicles				Electrical Mach.				Non-Electrical Mach.				Basic Chemicals				Pharmaceuticals				Paper			
	Panel				*Panel*				*Panel*				*Panel*				*Panel*				*Panel*			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
'76	1.30	1.21	1.11		1.53	1.11	1.18		1.16	1.10	1.08		1.24	1.15	1.14		1.20	1.13	1.13		1.37	1.22	1.23	
'77	1.25	1.17	1.08		1.52	1.10	1.17		1.15	1.10	1.08		1.22	1.15	[illegible]		1.20	1.13	1.13		1.37	1.21	1.24	
'78	1.25	1.16	1.08		1.51	1.11	1.18		1.15	1.10	1.07		1.22	1.14	1.12		1.20	1.13	1.13		1.38	1.23	1.23	
'79	1.26	1.17	1.07		1.49	1.11	1.16		1.15	1.10	1.07		1.21	1.14	1.12		1.19	1.12	1.12		1.37	1.22	1.23	
'80	1.25	1.16	1.06		1.49	1.11	1.15		1.15	1.10	1.07		1.23	1.14	1.12		1.18	1.12	1.12		1.37	1.22	1.23	
'81	1.23	1.14	1.05	1.22	1.46	1.10	1.14	1.26	1.15	1.09	1.06	1.07	1.24	1.15	1.12	1.16	1.18	1.11	1.11	1.12	1.37	1.22	1.23	1.23
'82		1.13	1.04	1.21		1.11	1.12	1.27		1.09	1.06	1.06		1.16	1.12	1.16		1.11	1.11	1.12		1.22	1.22	1.21
'83		1.12	1.04	1.20		1.11	1.10	1.24		1.09	1.05	1.06		1.17	1.13	1.18		1.11	1.11	1.11		1.23	1.22	1.21
'84		1.11	1.04	1.20		1.06	1.09	1.20		1.09	1.05	1.06		1.19	1.13	1.18		1.11	1.11	1.11		1.24	1.22	1.22
'85			1.03	1.19			1.08	1.16			1.05	1.05			1.12	1.16			1.11	1.11			1.21	1.21
	1	1	11	1	8	1	11	3	IX	3	16	12	17	8	20	4	14	6	23	6	18	2	12	2

Note: Average RTS for each industry is calculated as a simple mean of RTS of all sample firms (belonging to the industry and panel) which were present in the data set for all years. Panel 1 firms span the years 1976-S 1, panel 2 firms span the years 1976-84, panel 3 firms span the years 1976-85, and panel 4 firms span the years 198 1-85. The last row indicates the number of firms used in the computations for each panel respectively. The years reported in this table refer to the latter half of the fiscal year. Hence, 1981 represents the fiscal year 1980- 198 1.

Table 6
Test of Constant Returns to Scale (1980-81)

	Mean t-statistic by range of RTS [a,b]					
RTS	***Auto Vehicles***	***Electrical Machinery***	***Non-Elec. Machinery***	***Basic Chemicals***	***Pharma-ceutirals***	***Paper***
0.85 - 0.95	-0.71 (7%)	-0.80 (4%)				
0.95 - 1.05	0.18 (36%)		0.74 (23%)		0.56 (6%)	
1.05 - 1.15	1.67** (36%)	1.78** (33%)	2.55* (54%)	1.74** (50%)	2.39* (60%)	
1.15 - 1.25	1.75** (21%)	3.10’ (8%)	2.30* (23%)	3.18* (36%)	3.00* (28%)	2.74* (41%)
1.25 - 1.35		4.86* (25%)		3.00’ (8%)	2.21* (6%)	4.23* (30%)
1.35 - 1.45		5.08* (8%)		2.08* (6%)		3.30* (24%)
1.45 - 1.55		4.95* (4%)		2.70* (2%)		2.86’ (5%)
1.55 - 1.65		4.84* (8%)				
1.65 - 1.75		4.40* (8%)				

Note: [a] Mean t-statistic for each range of RTS in an industry is calculated by averaging over the t-statistics for the difference between estimated RTS and 1 of all firms with estimated RTS lying in that range and belonging to the industry. * implies significance at 5% level. ** implies significance at the 10% level. [b] Number in parenthesis indicates the percentage of sample firms with estimated RTS within the specified range.

Table 7

Returns to Scale (1980-81)[a]

	Auto Vehicles	*Electrical Machinery*	*Non-Elec. Machinery*	*Basic Chemicals*	*Pharma-ceuticals*	*Paper*
Average RTS[b]	1.08 (0.99)	1.28 (3.43*)	1.10 (2.08*)	1.15 (2.39*)	1.13 (2.44*)	1.30 (3.33*)
Weighted RTS[c]	0.99 (-0.06)	1.11 (1.80**)	1.04. (1.02)	1.11 (1.81**)	1.08 (1.55)	1.22 (2.66*)
Production in CRS range[d]	95%	35%	71%	52%	59%	17%
Production in IRS range[e]	5%	65%	29%	48%	41%	83%

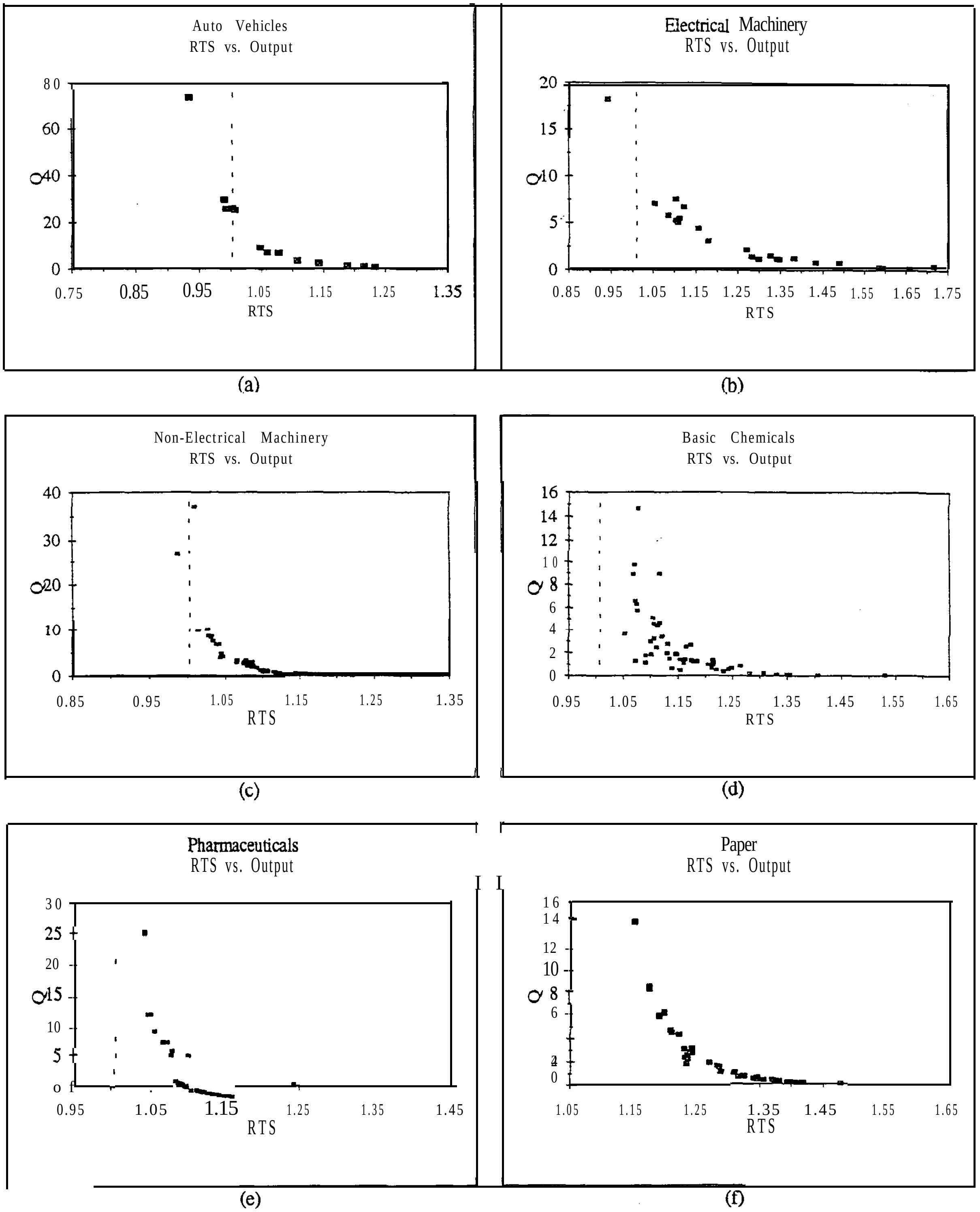
Note: [a] Number in parenthesis denotes the t-statistic for the difference between estimated RTS and 1. * implies significance at the 5% level. ** implies significance at the 10% level. [b] Average RTS for each industry is calculated as a simple mean of RTS over all sample firms belonging to the industry. [c] Weighted RTS is calculated by weighting each firm's RTS by its share in sample industry output. [d] Percent of sample industry output that is produced by firms for which CRS cannot be rejected at either 5% or 10% level of significance. [e] Percent of sample industry output that is produced by firms for which CRS is rejected at either 5% or 10% level of significance.

Table 8
Returns to Scale for Balanced Panel 1980-81 to 1984-85 & 1988-89

	Auto Vehicles			Electrical Mach.			Non-Elec Mach.			Basic Chemicals			Pharmaceuticals			Paper		
Year	*Avg. RTS*	***Wtd. RTS***	*% of Total Output*	*Avg. RTS*	***Wtd.*** *RTS*	*% of Total output*	*Avg. RTS*	***Wtd.*** *RTS*	*% of Total Output*	*Avg. RTS*	***Wtd.*** *RTS*	*% of Total Output*	*Avg.* ***RTS***	***Wtd.*** *RTS*	*% of Total output*	*Avg. RTS*	***Wtd.*** *RTS*	*% of* ***Total Output***
1981	1.06	C.99	80.1%	1.16	1.08	35.1%	1.07	I.03	60.8%	1.13	1.10	40.0%	.1I	1.08	66.2%	1.23	.20	44.4%
1982	1.06	C.98	80.4%	1.15	I.06	40.8%	1.06	1.03	62.2%	1.13	1.10	40.6%	.1I	I.08	61.0%	I.22	.19	47.3%
1983	1.05	C.98	75.3%	1.13	1.05	39.3%	1.06	1.02	61.8%	1.14	1.11	38.3%	.11	1.08	57.2%	1.22	.19	51.2%
1984	1.05	0.99	75.5%	1.11	1.03	38.9%	1.05	1.02	55.1%	1.14	1.11	40.4%	.11	1.08	50.0%	1.22	.19	45.3%
1985	1.05	ci.99	74.6%	1.10	1.02	36.7%	1.05	1.01	57.7%	1.13	1.10	36.5%	.11	1.08	49.6%	1.21	.18	43.5%
1989	I.03	0.98	62.9%	1.06	0.98	36.9%	1.04	I.00	59.4%	1.12	1.10	34.9%	.10	1.07	53.2%	1.20	.16	41.5%
Firms		12			14			26			22			29			13	

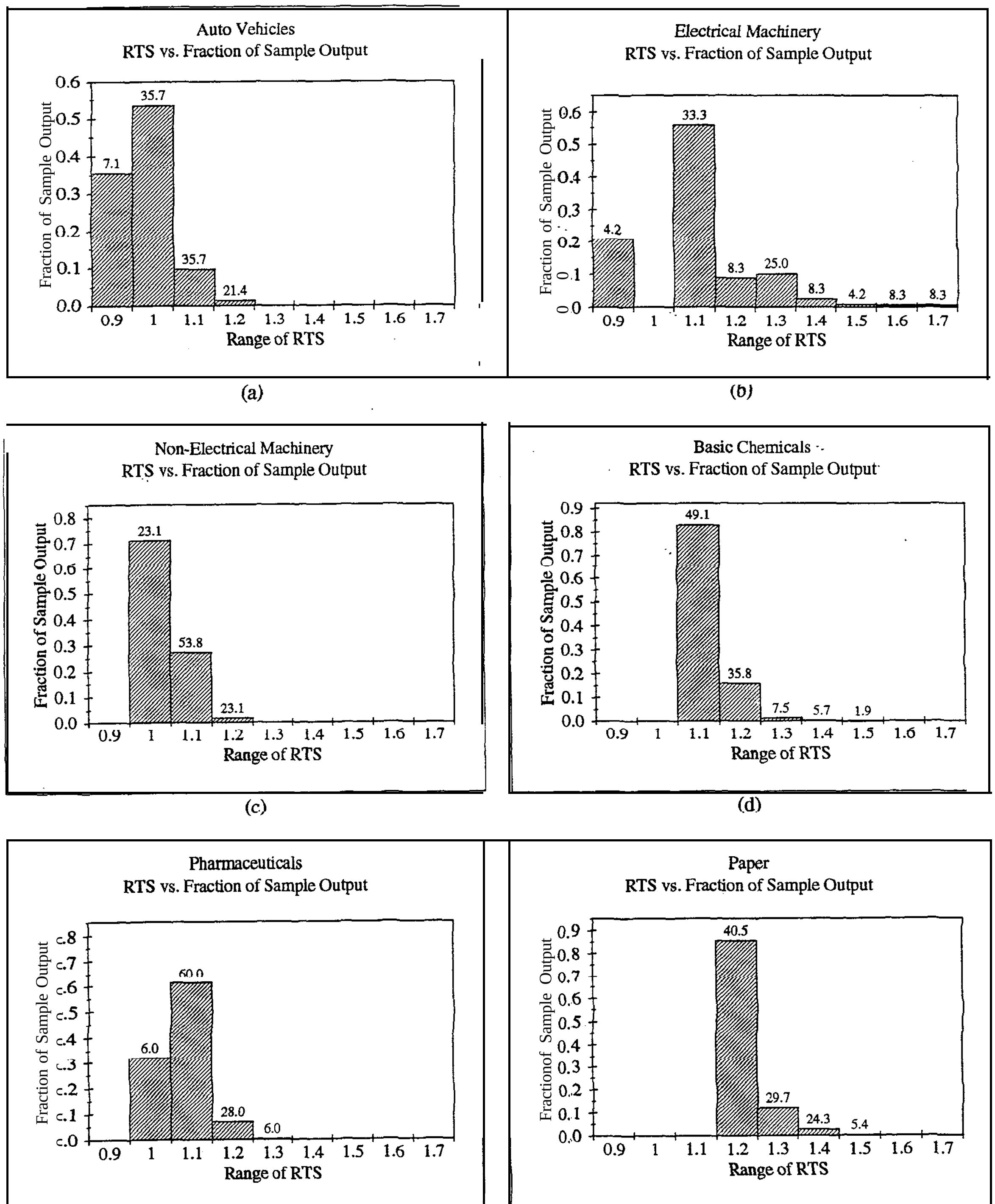
Note: [a] Average RTS for each industry and year is calculated as a simple mean of RTS of all sample firms (belonging to the industry) which were present in the data set for each year from 1980-81 to 1984-85 and 1988-89 [b] Similarly, weighted RTS is calculated by weighting each firm's RTS by its share in sample industry output. Total Output is the respective industry's total output as given in the ASI for the relevant years. The years reported in this table refer to the latter half of the fiscal year. Hence, 198 1 represents the fiscal year 1980- I98 I.

Figures 1 a-f



Note: Output is measured in thousands of constant 1985-86 Rupees. Each point represents a firm in 1980-81.

Figures 2a-f



(a) (b) (c) (d) (e) (f)

Note: Number above each bar represents the percent of sample firms producing in that range. Data is for 1980-81.